

# **EXHIBIT A**

**REDACTED VERSION OF  
DOCUMENT SOUGHT TO BE  
SEALED**

**IN THE UNITED STATES DISTRICT COURT  
NORTHERN DISTRICT OF CALIFORNIA  
SAN JOSE DIVISION**

SPACE DATA CORPORATION,	)	
	)	
Plaintiffs,	)	
	)	
v.	)	Case No. 5:16-cv-03260-BLF
	)	
ALPHABET INC., GOOGLE LLC, AND	)	
LOON LLC,	)	
	)	
Defendants.	)	
	)	
	)	
	)	

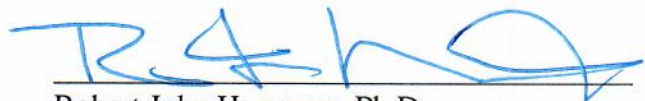
REBUTTAL EXPERT REPORT OF ROBERT JOHN HANSMAN, Ph.D.

REGARDING NON-INFRINGEMENT OF  
U.S. PATENT NOS. 9,643,706 AND 9,678,193

AND

SPACE DATA'S ASSERTED TRADE SECRETS  
AND CONFIDENTIAL INFORMATION

**CONTAINS HIGHLY CONFIDENTIAL—ATTORNEYS' EYES ONLY INFORMATION**

  
Robert John Hansman, Ph.D.

November 16, 2018

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testimony provided in this case. I also reserve the right to respond to any additional or revised opinions or theories of infringement of which I am not currently aware.

13. At this time, I have not created any exhibits to be used as a summary of, or as support for, my opinions apart from the materials below and attached to this report. I reserve the right to create any additional summaries, tutorials, demonstratives, charts, drawings, tables, and/or animations that may be appropriate to supplement or demonstrate my opinions, if I am asked to testify at trial.

### **III. QUALIFICATIONS AND EXPERIENCE**

14. I received a Bachelor's degree in 1976 from Cornell University, a Master's degree in Physics in 1980 and an interdisciplinary Ph.D. in Physics, Aeronautical and Astronautical Engineering, Electrical Engineering, and Meteorology in 1982 from MIT.

15. Since 1982, I have taught and conducted research in the Department of Aeronautics and Astronautics at MIT, initially as a Lecturer from 1982 through 1983, then as an Assistant Professor from 1983 through 1984, the Boeing Assistant Professor of Aeronautics and Astronautics from 1984 through 1985, the Esther and Harold E. Edgerton Assistant Professor from 1985 through 1987, an Associate Professor from 1987 through 1995, and a Professor from 1995 through 2006. Most recently, in 2006, I was appointed the T. Wilson Professor of Aeronautics and Astronautics.

16. I teach undergraduate and graduate courses in aircraft design and systems engineering, flight testing, spacecraft and aircraft instrumentation, flight guidance, airline management, and human supervisory control. I have conducted research in a broad range of air transportation topics, including using information technology to improve safety and efficiency.

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17. Over the course of my career, I have been a member of numerous organizations related to aeronautics, including the National Academy of Engineering (NAE), National Research Council Aeronautics & Space Engineering Board, American Institute of Aeronautics & Astronautics (Fellow), Royal Aeronautical Society (Fellow), NASA Aeronautics Advisory Council, Soaring Society of America (Director), Soaring Safety Foundation (Director), Atmospheric Environment Technical Committee, American Meteorological Society, Society of Automotive Engineers, Human Factors Society, Aeronautical Flight Measurements and Techniques Working Group, and Editorial Board of *Air Traffic Control Quarterly* and *Journal of Aircraft*.

18. Since 1982, I have served as a consultant and advisor on various aerospace-related topics. I am the chair of the U.S. Federal Aviation Administration Research Engineering & Development Advisory Committee (REDAC) and the co-director of the FAA Center of Excellence in Aviation Sustainability (ASCENT).

19. I received the AIAA Award for Best Paper in Thermophysics, the Presidential Young Investigator Award, the AIAA Losey Atmospheric Sciences Award, the FAA Excellence in Aviation Award, the Bose Award for Excellence in Teaching, and the Kriske Career Award from the Air Traffic Control Association.

20. I have over 6,000 hours of pilot in-command time in airplanes, helicopters and sailplanes, including meteorological, production and engineering flight test experience.

21. I am the named inventor on U.S. Patent Nos. 4,365,131; 4,628,726; 4,729,245; 5,039,439; 5,313,202; 6,389,333; and 7,428,449, which deal with methods of ice prevention and de-icing, flight information and control systems, low gravity fluid measurement systems, and systems and methods of workload determination.

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22. I have authored more than 300 technical publications, including those listed in my *curriculum vitae*.

23. As part of my activities at MIT, I have led a number of aircraft and UAV design and development efforts, which has included the design and development of lighter-than-air platforms. These include simple lighter than air designs as part of undergraduate classes and several hybrid lift vehicle designs developed in collaboration with the Lockheed Martin Skunk Works. I have designed and developed and used flight termination systems, most recently for the Jungle Hawk Owl long endurance UAV.

24. A true and correct copy of my *curriculum vitae* is attached as **Exhibit 2** and incorporated herein by reference.

#### **IV. LEGAL STANDARDS**

25. I am not an attorney or a legal expert, and I offer no opinions on the law. I have relied on instructions from counsel as to the applicable legal standards to use in arriving at my opinions in this Report.

##### **A. Patent Infringement**

26. I have been informed and understand that determining whether an asserted patent claim is directly infringed involves a two-step inquiry. First, the claim must be construed to determine its proper scope and meaning to one of ordinary skill in the art. Second, to find infringement by an accused product or method, the patent owner must show the presence of every limitation of the claim in the accused product or method either literally or under the doctrine of equivalents. I understand that there can be no infringement unless every limitation of the claim is present in the accused product or method either literally or equivalently.

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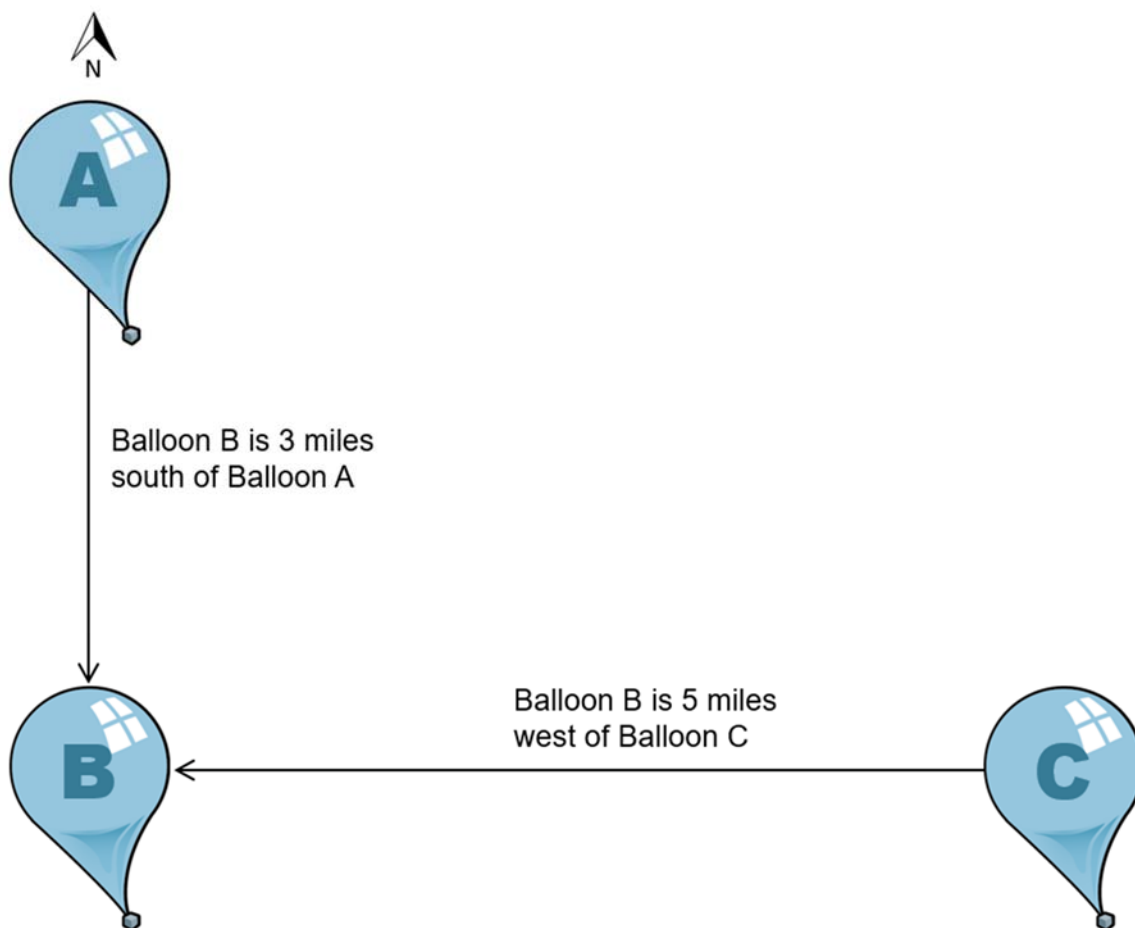
138. I disagree with Space Data’s and Dr. Pullen’s contention that the Loon system infringes claim 1 of the ’193 patent. Based on my analysis, it is my opinion that the Loon system does not infringe claim 1 of the ’193 patent.

**a. The Loon system does not perform the method step of “determining locations of one or more neighbor balloons relative to the determined location of the target balloon.”**

139. Claim 1 requires, among other limitations, the step of “determining locations of one or more neighbor balloons relative to the determined location of the target balloon.” In other words, the system must determine the *relative* location of balloons within the system.

140. Relative location has a standard meaning to one of skill in the art. A relative location is a location that is measured in relation to some other object or reference point—*i.e.*, it is a *vector* measured as the distance and direction from one object to another (*e.g.*, the relative location of Balloon B from Balloon A).

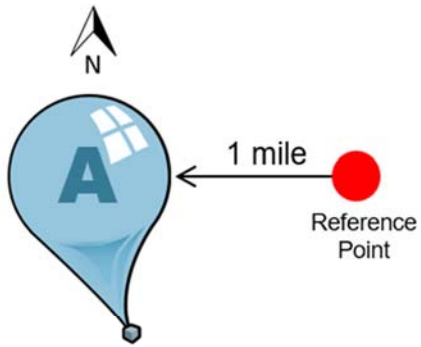
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141. Because a relative location is, by definition, determined in relation to another object or reference point, the same object will have different relative locations depending on what is used as the reference. In the balloon network illustrated above, for example, Balloon B has a relative location 3 miles south of Balloon A, but Balloon B also has a relative location 5 miles west of Balloon C.

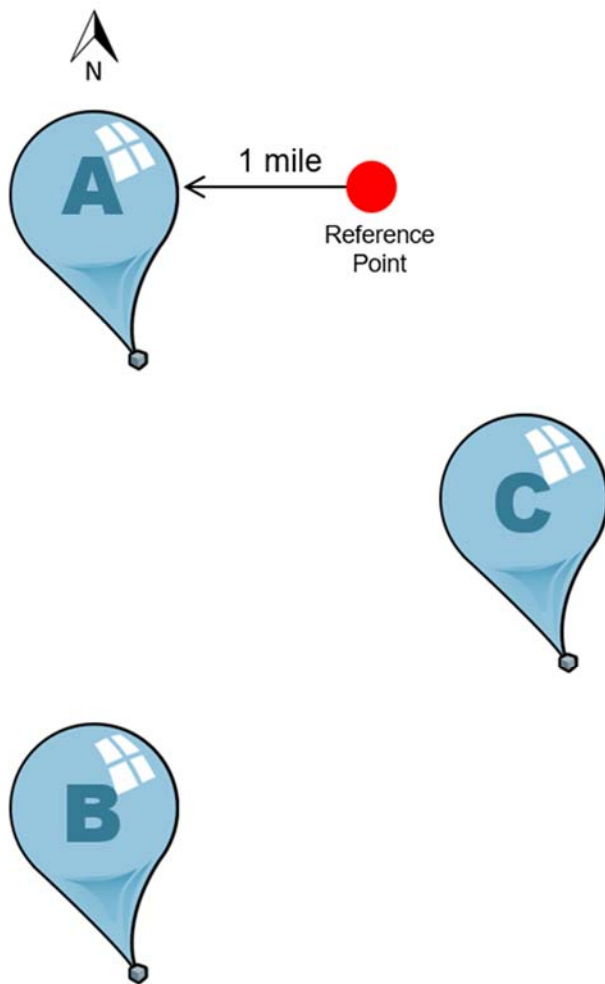
142. In contrast to a relative location, an absolute location is measured in relation to an absolute reference point (such as a fixed point on earth) or based on a fixed coordinate system (such as latitude, longitude, and altitude). When measuring the location of a balloon from an absolute reference point, the location of other balloons within the network is irrelevant.

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As an example, in the balloon network illustrated above, the location of Balloon A is 1 mile west of the absolute reference point on earth, shown as a red circle. Unless Balloon A moves, its location relative to that reference point will not change.

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As illustrated above, if Balloon C moves, the location of Balloon A relative to the location of Balloon C would be different, but the absolute location of Balloon A would be unchanged.

143. Claim 1 requires the step of “determining locations of one of more neighbor balloons relative to the determined location of the target balloon.” Thus, to infringe, the system must (a) determine the location of the target balloon and then (b) must also determine the location of one or more of its neighbors *relative to* the determined location of that target balloon. And for that second step, the system must determine the vector (*i.e.*, distance and direction) that the neighbor balloon is from the target balloon.

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144. In other words, to infringe claim 1, it is not sufficient to determine the location of the neighbor balloon in relation to an absolute reference point (such as a point on earth) and to also determine the location of the target balloon in relation to the same absolute reference point. Rather, the claim language requires determining the location of the neighbor balloons “relative to” the location of the target balloon.

145. As noted above, the ’193 patent describes a method for maintaining the desired spacing *between* balloons and therefore requires determining the location of a balloon *relative to* its neighbors. In contrast, the Loon stratospheric communications system does not, “determin[e] locations of one or more neighbor balloons relative to the determined location of the target balloon.” ’193 patent, claim 1. Specifically, the Loon system does not determine the location of any balloon in the network relative to the location of any other balloon in the network. In short, at no step in the control of Loon’s network of balloons does the system determine the distance and direction of one balloon from any other balloon within the network.

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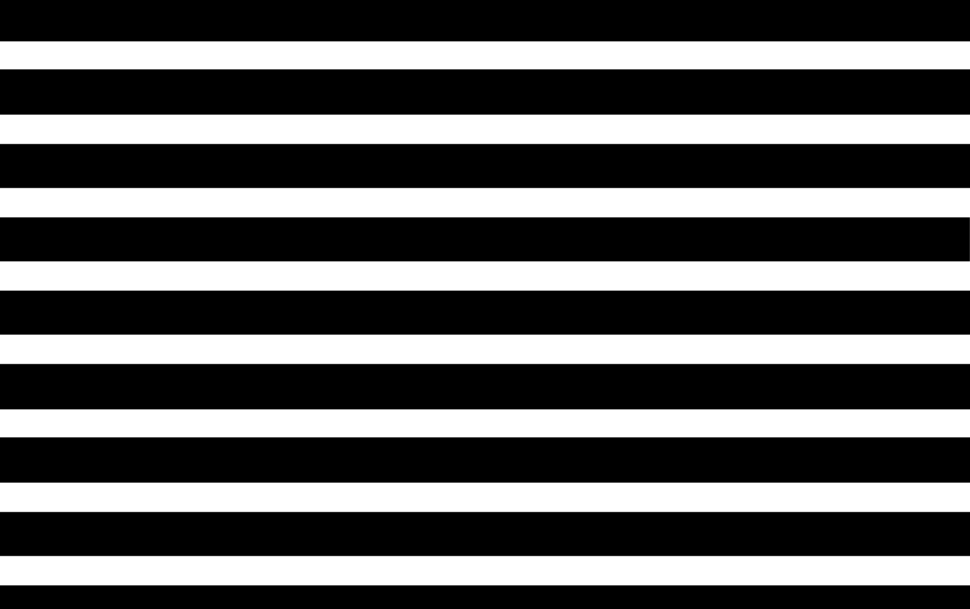
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322. I have reviewed all the photographs taken by Google's representatives during their February 15, 2008 tour of Space Data that have been produced in discovery in this action. Based on that review, it is my opinion that none of the photographs reveal non-public information concerning Space Data's Asserted Technical Trade Secrets, individually or collectively.

323. Many of the photographs are of the Google team's journey to and from Arizona. *See* GOOG-SD-00074305; GOOG-SD-0074323–2; GOOG-SD-0074327–29; GOOG-SD-0074331–43; GOOG-SD-00080966; GOOG-SD-00080981–83; GOOG-SD-00080985; GOOG-SD-00080998; GOOG-SD-00081003–06; GOOG-SD-00074283–98; GOOG-SD-00074310–12; GOOG-SD-00074315; GOOG-SD-00074317; GOOG-SD-00074320; GOOG-SD-00080967–75; GOOG-SD-00080984–90; GOOG-SD-00293623; and GOOG-SD-00293632–37. These photos clearly do not contain any confidential Space Data information.

324. Many other photographs are of the launching of Space Data balloons with payloads from the parking lot of Space Data's offices. *See* GOOG-SD-00074305; GOOG-SD-0074323–25; GOOG-SD-0074327–29; GOOG-SD-0074331–43; GOOG-SD-00080966; GOOG-SD-00080981–83; GOOG-SD-00080985; GOOG-SD-00080998; GOOG-SD-00081003–06; and GOOG-SD-00293624–30. I understand that Space Data does not consider its balloon launches, or anything discernable from observing a launch or the exterior of one of Space Data's payloads, to be confidential. *See* Knoblach Rule 30(b)(6) Dep. Tr. at 329:6–331:17. And, in any event, I have reviewed various news broadcasts from Space Data's offices showing Space Data's balloons being launched that, in my opinion, provide as much or more information about Space Data's balloons, the exterior of its payloads, and its balloon launch procedures as the Google

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balloon launch photos. *See, e.g.*, GOOG-SD-00292607; GOOG-SD-00296778; SD\_825705; SD\_825706; and SD\_825708.

325. [REDACTED]

[REDACTED]

[REDACTED] I understand that Space Data is not asserting that this process is one of its trade secrets. *See* Trade Secret Disclosure at 1–12. And this process is also depicted in the public news broadcasts about Space Data. *See* SD\_825705; SD\_825706; and SD\_825708.

326. [REDACTED]

[REDACTED]

[REDACTED]. I understand that Space Data is not asserting that Google has misappropriated any trade secrets related to its balloon manufacturing process or misused any confidential information related to that process. *See* Trade Secret Disclosure at 1–12.

327. [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

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328. [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

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[REDACTED]

[REDACTED].

329. I understand that Space Data has periodically permitted television news reporters and other journalists to record and broadcast stories from inside Space Data's NOCC. As noted above, I have reviewed some of these news broadcasts, and it is my opinion that the information concerning Space Data's NOCC visible in or discernable from [REDACTED]

[REDACTED]

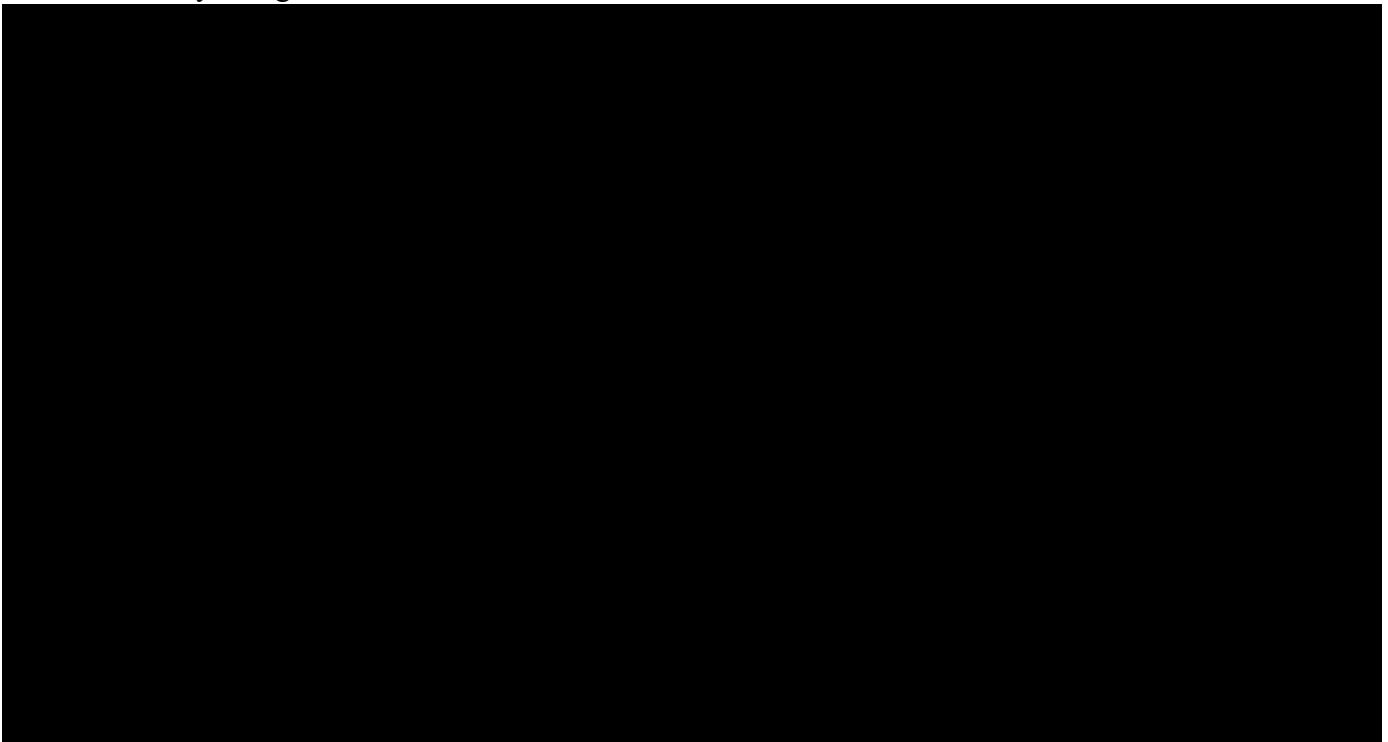
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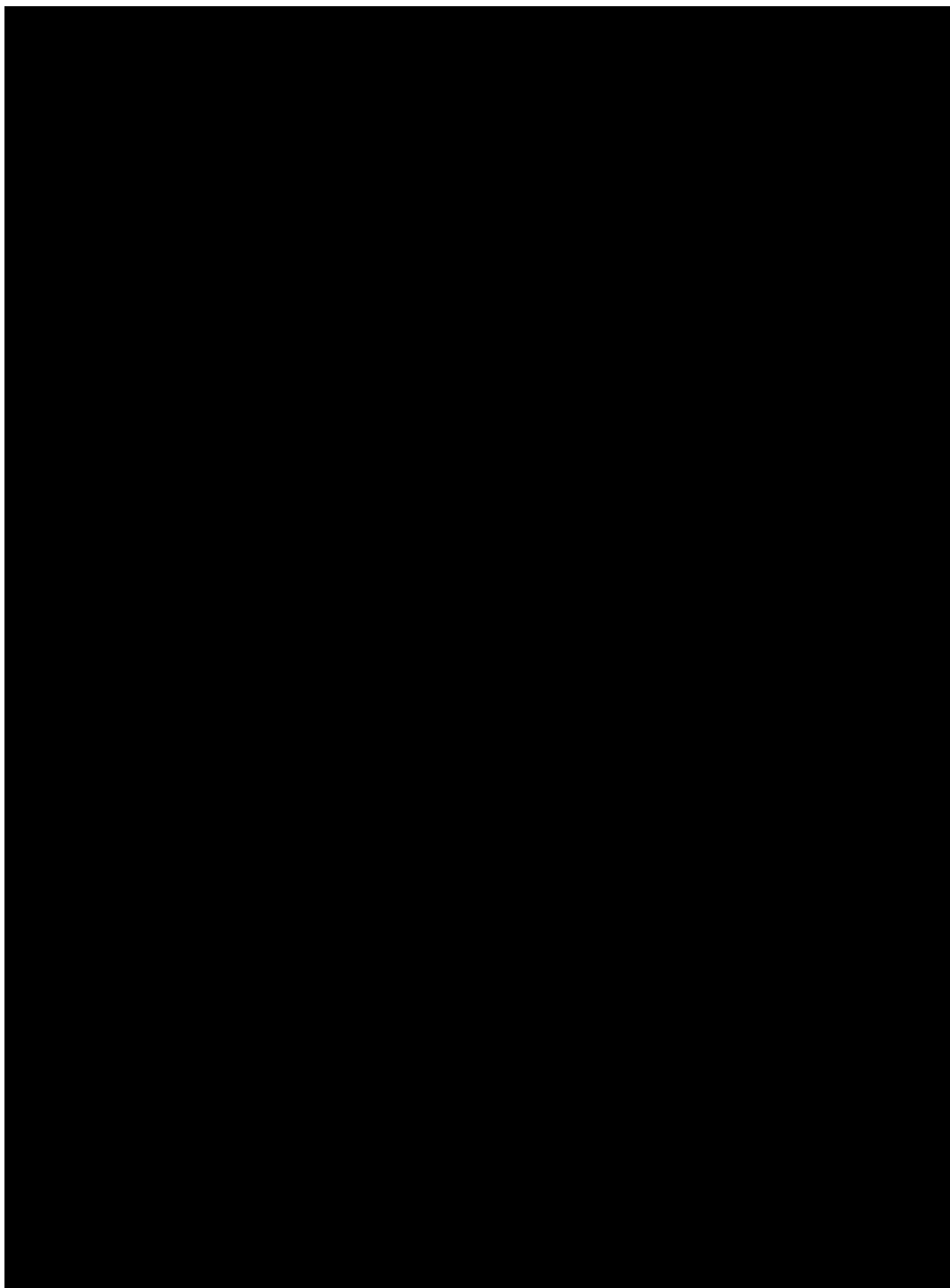
[REDACTED]

[REDACTED].

330. For example, reproduced below are representative examples of the photographs taken by Google in the NOCC:



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331. In comparison, reproduced below are screenshots of Space Data's NOCC from a WSJ.com online video news story about Space Data:

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GOOG-SD-00292607. According to the WSJ website, this video of Space Data's NOCC appears to have been taken around the same time that Google visited Space Data. *See* <https://www.wsj.com/video/bringing-wireless-to-hinterlands/DF067123-A7C8-4284-B50F-60A0B1EAC923.html> (showing a date of "Feb. 20" in the video description, which matches the Feb. 20, 2008 publication date of the accompanying WSJ printed news story on Space Data). I also understand from Mr. Knoblach's testimony that Wall Street Journal reporter Amol Sharma

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toured Space Data's facilities in early February 2008, shortly before Google's visit. *See* Knoblach Rule 30(b)(6) Dep. Tr. at 533:23–534:4.

332. Similarly, here are screenshots of Space Data's NOCC from a Phoenix, Arizona FOX affiliate television news broadcast from within Space Data's NOCC:



GOOG-SD-00296778. According to Space Data's website, this video of Space Data's NOCC was taken around March 2008. *See* <https://www.spacedata.net/news/in-the-news/>.

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Additionally, here is another screenshot from a different news broadcast from Space Data's NOCC by the same Phoenix, Arizona FOX television station:



GOOG-SD-00296776. According to Space Data's website, this video of Space Data's NOCC was taken around June 2010. See <https://www.spacedata.net/news/in-the-news/>.

333. [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

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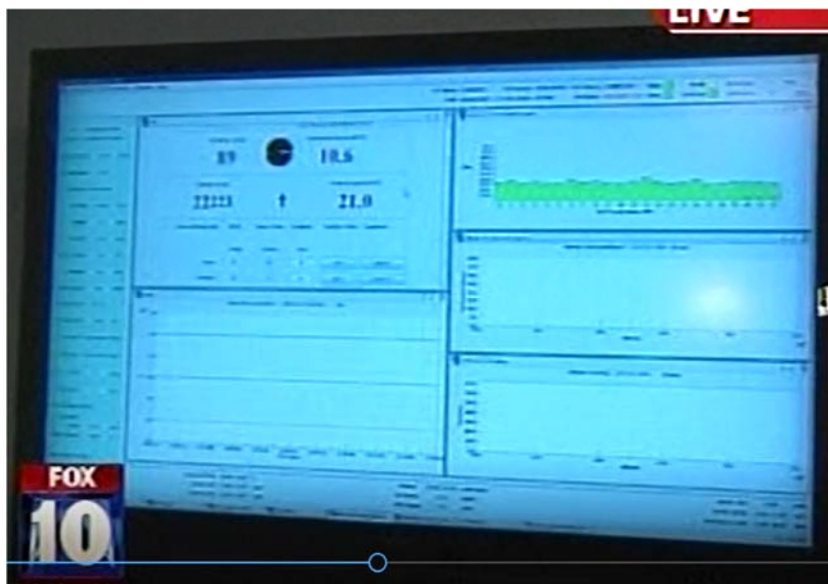
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334. [REDACTED]

[REDACTED]

[REDACTED], the public news broadcasts that I have reviewed do depict such information. Reproduced below are two examples:

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GOOG-SD-00296776.



SD\_825708.

335.

[REDACTED]

[REDACTED]

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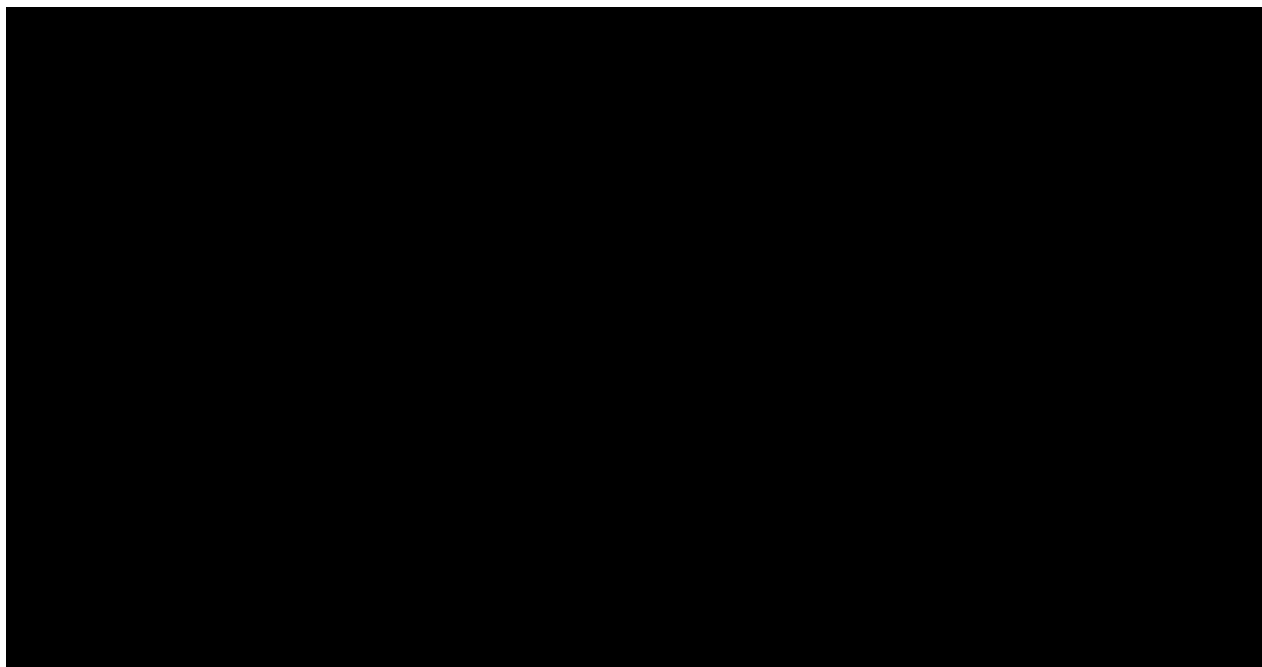
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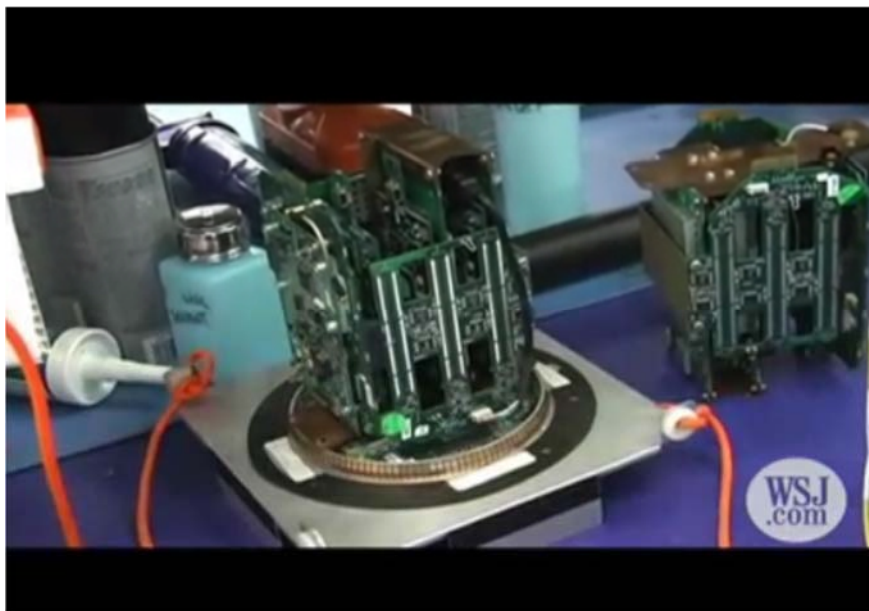
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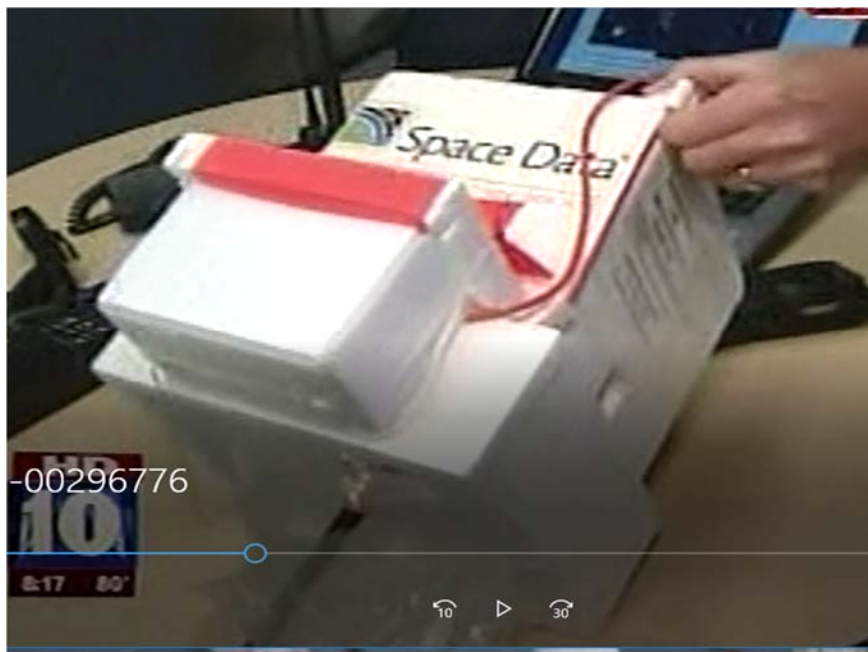
337. And here is a screenshot from the February 2008 WSJ.com video news story discussed above showing Space Data's payload:

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GOOG-SD-00292607.

338. And here is a screenshot from the March 2008 Fox news broadcast, showing the foam insulation exterior of Space Data's payload:



GOOG-SD-00296776.

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339. Similarly, here is an image from a Space Data presentation dated 2015 that I understand is publicly available on the internet:



GOOG-SD-00301199–230 at -205 (available at <https://docplayer.net/11167153-Connecting-air-ground-operators-through-the-upper-aerial-layer.html> (last accessed November 13, 2018)).

340. In sum, in my opinion neither the Google photographs reproduced above nor any others that I have reviewed disclose any more about the subject matter of Space Data Asserted Technical Trade Secrets than the WSJ.com video and other news broadcasts from Space Data's facilities and other public disclosures by Space Data that I have reviewed.

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362.

[REDACTED]

**C. Dr. Meyer's Statement Concerning the Value of Space Data's Asserted Technical Trade Secrets to Google**

363.

[REDACTED]

[REDACTED]

[REDACTED]

364. Dr. Meyer offers no basis for her conclusions regarding the supposed benefits to Google of Space Data's alleged trade secrets, individually or collectively, beyond Space Data's

370. For example, the specification of the '193 patent discloses: "To form the constellation of airborne communications platforms, paging transceivers are attached to lighter-than-air carriers, such as high altitude balloons similar to those used by the National Weather Service (NWS) yet modified to provide for regulated adjustable altitude control using methods such as venting and ballast dropping. . . . Computer regulated altitude control and computerized

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tracking are utilized. The SNS platforms are regulated to maintain a desired altitude within a predetermined altitude range, as, for example, in the stratosphere over Earth, as they drift along with existing wind currents.” ’193 patent at 11:38–43; 11:54–58. The specification goes on to describe in detail how to implement such a stratospheric balloon communications system.

371. [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

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[REDACTED].

372. A 2003 article by Space Data’s Chief Technology Officer, Eric Frische, entitled “A Low-Cost, Free Drifting Ballooncraft Constellation Providing Telecommunications to Rural Areas,” includes a detailed discussion of Space Data’s system and technology. SD\_191247–57.

It discloses, among other information:

*Wind patterns at 100,000 feet are dominated by large global circulation flows which are uniform and have generally predictable seasonal variations. Over 60 years of National Weather Service meteorological data is available to provide baseline data for simulations verifying that the winds are uniform enough to maintain an evenly spaced constellation. Once aloft, the future position of each SkySite Platform in the constellation can be projected. Based on this predictive knowledge, Space Data’s SkySite Control Center (SCC) can proactively launch individual SkySite Platforms as needed to fill potential developing coverage gaps or adjust the altitude of individual SkySites [sic] Platforms to a new altitude with preferential winds in order to keep the constellation uniformly spaced.*

SD\_191247–57 at -48 (emphasis added).

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373. The Frische article also provides details of Space Data's testing of its wind steering technology, explaining: "Winds from 72k to 90k feet were below 20 miles per hour. . . . SkySite Platform float altitudes ranged from 70 thousand to 90 thousand feet during the trials as these winds provided a wide range of wind directions with minimal changes in altitude, as seen in Figure 14. By controlling the SkySite Platform altitude between 74k and 83k feet, all wind directions were available." SD\_191247-57 at -54. The referenced Figure 14 is a graph of the wind conditions Space Data encountered at various altitudes during these test flights. SD\_191247-57 at -54.

374. [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

375. [REDACTED]

[REDACTED]

[REDACTED]

376. Also, as noted, Space Data has allowed journalists to record and broadcast video from its NOCC, and it has provided those journalists with information concerning Space Data's [REDACTED]. For

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example, the WSJ.com story about Space Data shows a wall monitor in Space Data's NOCC with the location and vector of Space Data's balloons in flight:



While the monitor is displayed, the narrator of the WSJ.com story explains:

*While they're airborne, the balloons are monitored at Space Data's command and control center where they're projected on a big map. The blue thumbnails mark the balloons, with the circles around them representing their wireless coverage area. White vectors show where the balloons will end up in eight hours as they drift across the stratosphere. Engineers are able to adjust the balloon's altitude and keep them in place.*

GOOG-SD-00292607.

377. [REDACTED]

[REDACTED]

[REDACTED]

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[REDACTED]

379. Additionally, Dr. Meyer's statements concerning the benefits to Google of Space Data's Asserted Technical Trade Secrets fail to take into account the fundamental differences between Space Data's balloon communication system and the system subsequently developed by Loon.

380. [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

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[REDACTED]

[REDACTED]

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[REDACTED]

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[REDACTED]

381. Loon, in contrast, utilizes ultra-long duration super-pressure balloons that can stay aloft for months. [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED] Loon payloads look nothing like the Space Data payloads depicted in the Google photographs and in the public news broadcasts; they are much larger, heavier, and more complex; they are not encased in a Styrofoam; and they include solar panels for generating power while in flight.

382. Given the very different configurations and design characteristics of Space Data's system and Loon's, and the very different operational approaches of the two systems, in my opinion, knowledge of Space Data's Asserted Technical Trade Secrets, individually or collectively, would be of little value or utility to establish the viability of a system such as Loon's.

## **X. CONCLUSION**

383. Based on my knowledge, experience, education and professional judgment, my understanding of the legal standards in this case, and my review of the evidence, it is my opinion (1) that Google has not infringed any asserted claim of the '193 and '706 patents, (2) that there are multiple acceptable non-infringing alternatives to the asserted claims of the '193 patent, and (3) that Dr. Meyer's assumptions, understandings and statements about Google's alleged

## Exhibit 2

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**Education**

MASSACHUSETTS INSTITUTE OF TECHNOLOGY - Cambridge, MA

- Ph.D. in Physics, June 1982.

Thesis under Professor Walter Hollister, "The Interaction of Radio Frequency Electromagnetic Waves with Atmospheric Water Droplets and Applications to Aircraft Ice Prevention."

- M.S. in Physics, May 1980.

Thesis under Professor George Bekefi, "Reflexing in a Relativistic e-Beam Diode."

CORNELL UNIVERSITY - Ithaca, NY

- A.B. Magna Cum Laude in Physics & Distinction in all Subjects, June 1976.

**Member**

National Academy of Engineering (NAE), FAA Research and Development Advisory Committee (Chair), NRC Aeronautics & Space Engineering Board, American Institute of Aeronautics & Astronautics (Fellow), Royal Aeronautical Society (Fellow), NASA Aeronautics Advisory Council, Soaring Society of America (Director), Soaring Safety Foundation (Director), , Atmospheric Environment Technical Committee, American Meteorological Society, Society of Automotive Engineers, Human Factors Society, Aeronautical Flight Measurements and Techniques Working Group, Editorial Board *Air Traffic Control Quarterly* and *Journal of Aircraft*, Phi Beta Kappa, Sigma Xi.

**Experience**

MIT DEPARTMENT OF AERONAUTICS AND ASTRONAUTICS - Cambridge, MA

1982 - present

Faculty member in the fields of Flight Safety, Flight Information Systems, Instrumentation, Aviation Meteorology, Human Factors, Air Transportation

Head of Systems Sector; Director of the International Center for Air Transportation.

2006 T. Wilson Professor of Aeronautics and Astronautics

1995 Professor.

1987 Associate Professor.

1985 Esther and Harold E. Edgerton Assistant Professor.

1984 Boeing Assistant Professor of Aeronautics and Astronautics.  
1983 Assistant Professor.  
1982 Lecturer.

PRIVATE CONSULTANT - Cambridge, MA

1982 - present

Consultant for numerous firms on aerospace related topics.

MIT FLIGHT TRANSPORTATION LABORATORY - Cambridge, MA

1980 - 1982

Graduate Research Assistant working on the physics of advanced aircraft ice prevention concepts.

MIT RESEARCH LABORATORY OF ELECTRONICS - Cambridge, MA

1976 - 1980

Graduate Research Assistant working on high power relativistic electron beam magnetrons and high current density diodes.

FRANCIS & JACKSON ASSOCIATES - Marion, MA

1976 - 1977

Consultant working on total-energy wind shear detection and autothrottle control.

CORNELL UNIVERSITY DEPARTMENT OF PHYSICS - Ithaca, NY

1975 - 1976

Recitation Instructor involved in teaching basic courses in Mechanics and Modern Physics (Optics and Quantum Mechanics).

SCHWEIZER AIRCRAFT CORPORATION - Elmira, NY (also Sugarbush, VT, Franconia, NH, North Conway, NH, and Plymouth, MA)

Summers 1971-1977

Glider and airplane flight instructor, glider and banner tow pilot, ferry pilot and test pilot for several companies.

FLIGHT EXPERIENCE - 6000+ hours: Commercial, Multi-Engine, Glider Airplane, Helicopter, Instrument, Remote Pilot and Flight Instructor Ratings. Type rated in Lear Jet 24, 35 and 55 series. Graduate of the Union Alpen Seelflugschule (Neideroblarn, Austria). Extensive mountain and instrument flight experience. Engineering, Production, and Meteorological Flight Test Experience.

## **Awards**

2015 Best Article in Journal of Cognitive Engineering and Decision Making  
2013 Elected to the National Academy of Engineering  
2012 CNA Award for Operational Analysis  
2012 Kevin Corker Award for the Best Paper at 10<sup>th</sup> USA/Europe ATM, R&D Seminar  
2007 Plenary Lecture at American Control Conference  
2006 T. Wilson Chair of Aeronautics & Astronautics  
2005 Best Paper in 6<sup>th</sup> USA/Europe ATM, R&D Seminar  
2005 AIAA Dryden Lecture in Aviation Research  
2005 Kriske Career Award from Air Traffic Control Association  
2004 Laurel from Aviation Week and Space Technology  
2002 Fellow of the American Institute of Aeronautics & Astronautics.  
2001 NASA Turning Goals into Reality Award  
1998 Bose Award for Excellence in Teaching  
1998 FAA/Eurocontrol Best Paper in Air Traffic Management  
1997 FAA Excellence in Aviation Award.  
1994 AIAA Losey Atmospheric Sciences Award.  
1990 OSTIV Diploma for Technical Contribution.  
Federation Aeronautique Internationale Gold C Award with 3 Diamonds.  
1986 Presidential Young Investigator Award.  
1985 Esther & Harold E. Edgerton Professorship.  
1984 Boeing Professorship in Aeronautics & Astronautics.  
1986 AIAA Award for the Best Paper in Thermophysics.  
1989 Soaring Society of America, Exceptional Service Award.  
1980 and 1990 Region 1 Soaring Champion.  
1984 NASA Astronaut Selection Finalist.

## **Patents**

Microwave Ice Prevention System, U.S. Patent #4365131 issued December 21, 1982.

Method and Apparatus for Measurement of Ice Thickness Employing Ultrasonic Pulse-Echo Technique, U.S. Patent #4628736 issued December 16, 1986.

Method and Apparatus for Monitoring Liquid Volume/Mass in Tanks, U.S. Patent #4729245 issued March 8, 1988.

Optically Indicating Surface De-Icing Fluids, U.S. Patent #5039439 issued August 13, 1991.

Method and Apparatus for Detection of Ice Accretion - Remote IR Techniques, U.S. Patent #5313202 issued May 17, 1994.

Integrated Flight Information and Control System, U.S. Patent #6,389,333, issued May 14, 2002.

System and Method for Measuring the Workload of a Driver. U.S. Patent #7428449, issued September 23, 2008.

### **Video Production**

“MIT Video Series on Measurement” (author, co-producer, and presenter), 1995:

- “Introduction to Measurement”
- “Calibration, Accuracy and Error”
- “Measuring Dynamic Variables”
- “Contact Temperature Measurement”
- “Infrared Temperature Measurement”
- “Distance, Velocity and Acceleration”
- “Mass, Force, Strain, Torque, and Pressure”
- “Measurement”
- “Fluid Quantity and Flow”

### **Congressional Testimony**

“The Dynamics of the Emerging Capacity Crisis in the U.S. Air Traffic Control System” House Appropriations Committee – Subcommittee on Transportation, 3/15/01.

“Developing the Next Generation Air Traffic Management System” House Science Committee – Subcommittee on Space and Aeronautics”, 7/19/01.

“A Review of Aeronautics R&D at FAA and NASA” House Science Committee – Subcommittee on Space and Aeronautics”, 3/6/03.

“The Future of Aeronautics at NASA” House Science Committee – Subcommittee on Space and Aeronautics”, 3/16/05.

“Financing the Next Generation Air Transportation System” House Transportation and Infrastructure Committee – Aviation Subcommittee, 9/27/05.

“The Federal Aviation Administration’s Research and Development Capability” House Science Committee – Subcommittee on Space and Aeronautics”, 3/22/07.

“A Review of the Federal Aviation Administration’s Research and Development Program” House Science Committee – Subcommittee on Space and Aeronautics”, 2/16/11.

“Unmanned Aircraft Systems (UAS) Research and Development” House Committee on Science, Space and Technology”, 1/21/15.

“Transforming America’s Air Travel” House Committee on Science, Space and Technology”, 6/11/15.

## **Books**

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“Characteristics of Instrumentation,” Chapter 1, pp. 3-10 in The Measurement, Instrumentation and Sensors Handbook, Webster, J., Editor, CRC Press LLC, Boca Raton, FL, January 1999 (reprinted and updated 2013).

(with Feron, E. (Editor), Balakrishnan, H., Clarke, J.P., and, Jimenez, H.), “Challenges in Aerospace Decision and Control: Air Transportation Systems” pp. 109-136 in Advances in Control System Technology for Aerospace Operations, Springer Link, SBN: 978-3-662-47693-2 (Print) 978-3-662-47694-9 (Online)

## **Journal Articles**

“Droplet Size Distribution Effects on Aircraft Ice Accretion,” *Journal of Aircraft*, Vol. 22, No. 6, June 1985.

(with M. Kirby), “Measurement of Ice Accretion Using Ultrasonic Pulse-Echo Techniques,” *Journal of Aircraft*, Vol. 22, No. 6, June 1985.

“Measurement of Individual Hydrometeor Absorption Cross Sections Utilizing Microwave Cavity Perturbation Techniques,” *Journal of Atmospheric and Oceanic Technology*, Vol. 1, No. 4, December 1984.

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(with L. Peterson and E. Crawley), "Nonlinear Fluid Slosh Coupled to the Dynamics of a Spacecraft," *AIAA Journal*, Vol. 27, No. 9, September 1989.

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(with Hayley Davison Reynolds, Tom Reynolds), "Human Factors Implications of Continuous Descent Approach Procedures for Noise Abatement in Air Traffic Control" , *Air Traffic Control Quarterly*, **14(1)**, pp. 25-45, 2006.

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(with Aleksandra L. Mozdzanowska and Roland E. Weibel) “Feedback Model of Air Transportation System Change: Implementation Challenges for Aviation Information Systems”, *IEEE Journal*, **96**, Issue 12, pp. 1976-1991, 2009.

(with Philippe Bonnefoy and Richard de Neufville) ”Effective Development of Multi-Airport Systems; A Worldwide Perspective”, *Journal of Transportation Engineering*, **136**, Issue 11 2010.

(with Sgouris Sgourdis and Philippe Bonnefoy) “Air Transportation in a Carbon Constrained World: Long-term Dynamics of Policies and Strategies for Mitigating the Carbon Footprint of Commercial Aviation”, *Transportation Research - Part A Policy and Practice*, 45, Issue 10, 2011.

(with Morrison, J. and Sgourdis, S.) “Game Theory Analysis of the Impact of Single Isle Aircraft Competition on Fleet Emissions”, *Journal of Aircraft*, **49**, No.2 pp. 483-494, March-April 2012.

(with Churchill, A, Ball, M. and Donaldson, A.) “Integrating Best-Equipped Best-Served Principles in Ground Delay Programs,” *Air Traffic Control Quarterly*, **20**, No 1, 2012.

(with Simaiakis, I, Khadilkar, H., Balakrishnan, H., Reynolds, T. G., Reilly, B., and Urllass, S.) “Demonstration of Reduced Airport Congestion through Pushback Rate Control”, *Transportation Research Part A: Policy and Practice* (in review).

(with Marias, K., Reynolds, T., Uday, P, Muller, D, Lovegren, J. and Dumont, J.) Evaluation of Potential Near Term Operational Changes to Mitigate Environmental Impacts of Aviation” *Proceedings of the Institution of Mechanical Engineers, Part G: Journal of Aerospace Engineering*, DOI: 10.177/0954419112454095, 1-23, July 2012.

(with Morrison,J. and Yutko, B.) “Transitioning the U.S Air Transportation System to Higher Fuel Costs” *Transportation Research Record: Journal of the Transportation Research Board*, **2266**, July 2012.

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(with Sandberg, M., Simaiakis, I., Balakrishnan, H. and Reynolds, T. G.) “A Decision Support Tool for Pushback Rate Control of Airport Departures” *IEEE Transactions on Systems, Man and Cybernetics Part C* (2014).

(with Palacios, R.) “Filtering Enhanced Traffic Management System (ETMS) Altitude Data” *Metrology and Measurement Systems* **20**, no. 3, <http://dx.doi.org/10.2478/mms-2013-0039>.

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(with Silva, S., and Jensen, L.) “Safety Benefit of ADS-B Traffic and Weather Uplink Services”, *Journal of Aerospace Information*, Vol. 12, No. 8, pp. 579-586, doi:10.2514/1.I010364

(with Li, L., Das, S., Palacios, R., and Srivastava, A.) “Analysis of Flight Data Using Clustering Techniques for Detecting Abnormal Operations”, *Journal of Aerospace Information*, Vol. 12, No. 9 (2015), pp. 587-598. <http://dx.doi.org/10.2514/1.I010329>.

(with Silva, S.) . "Divergence Between Flight Crew Mental Model and Aircraft System State in Auto-Throttle Mode Confusion Accident and Incident Cases" *Journal of Cognitive Engineering and Decision Making* [15553434] . (2015).

(with Li, L., Palacios, R., and Welch, R.) “Anomaly Detection via a Gaussian Mixture Model for Flight Operation and Safety Monitoring”, *Transportation Research, Part C*, **64**, March 2016, pp. 45–57, [doi:10.1016/j.trc.2016.01.007](https://doi.org/10.1016/j.trc.2016.01.007).

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### **Additional Publications**

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(with R. Shefer and G. Bekefi), "Self-Pinching in a Laser Irradiated Relativistic e-Beam Diode," Bulletin of the American Physical Society, April 1978.

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"Microwave Ice Prevention," Proceedings of the Joint University Program for Air Transportation Research, NASA Conference Publication 2224, 1981.

"The Interaction of Radio Frequency Electromagnetic Fields with Atmospheric Water Droplets and Applications to Aircraft Ice Prevention," MIT Flight Transportation Laboratory Report R82-5, 1982.

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(with Kar, R., Bonnefoy, P., Sgouridis, S.) “Dynamics of Implementation of Mitigating Measures to Reduce Commercial Aviation’s Environmental Impacts” 9<sup>th</sup> AIAA Aviation Technology, Integration, and Operations Conference, Hilton Head, AIAA-2009-6935. September 2009.

(with Abrahamson, N. et al) Advancing Aeronautical Safety, National Academy Press, Washington, D.C., September 2010

(with Morrison, J. and Bonnefoy, P.) “Investigation of the Impact of Effective Fuel Cost Increase on the US Air Transportation Network and Fleet”, 10<sup>th</sup> AIAA Aviation Technology, Integration, and Operations Conference, Fort Worth, Oct 2010.

(with Donaldson, A.) “Capacity Improvement Potential for the New York Metroplex Region”, 10<sup>th</sup> AIAA Aviation Technology, Integration, and Operations Conference, Fort Worth, Oct 2010.

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(with Churchill, A, Ball, M. and Donaldson, A.) “Integrating Best-Equipped Best-Served Principles in Ground Delay Programs,” USA/Europe ATM R&D Seminar, June 2011.

(with Histon, J) “The Structure Hierarchy: a Framework for Understanding Air Traffic Controller Complexity”, Naturalistic Decision Making 2011, June 2011.

(with Dumont, J. and Reynolds, T.) “Fuel Burn and Emissions Reduction Potential of Low Power / Low Drag Approaches”, 11<sup>th</sup> AIAA Aviation Technology, Integration and Operations (ATIO) Conference, Virginia Beach, September 2011.

(with Gariel, M. and Frazzoli, E) “Impact of GPS and ADS-B Accuracy on Conflict Detection Performance in Dense Traffic”, 11<sup>th</sup> AIAA Aviation Technology, Integration and Operations (ATIO) Conference, Virginia Beach, September 2011.

(with Kunzi, F) “Mid-Air Collision Risk and Areas of High-Benefit for Traffic Alerting Systems”, 11<sup>th</sup> AIAA Aviation Technology, Integration and Operations (ATIO) Conference, Virginia Beach, September 2011.

(with Kunzi, F) “Survey of Potential ADS-B Benefits for the Soaring Community”, 11<sup>th</sup> AIAA Aviation Technology, Integration and Operations (ATIO) Conference, Virginia Beach, September 2011.

(with Morrison, J. and Sgouridis, S.) “Game Theory Analysis of the Impact of Single Isle Aircraft Competition on Fleet Emissions ”, 11<sup>th</sup> AIAA Aviation Technology, Integration and Operations (ATIO) Conference, Virginia Beach, September 2011.

(with Li, L. and Gariel, M.) “Detection of Anomalous Flights Using Cluster Analysis of Digital Flight Data Recorder (DFDR) Data”, 30<sup>th</sup> Digital Avionics Systems Conference, Seattle, October 2011.

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(with Butchibabu, A, Grayhem R. and Chandra, D.) “NextGen RNAV and RNP Charts: Evaluating a De-Cluttering Technique”, 31<sup>st</sup> Digital Avionics Systems Conference, Williamsburg VA, Oct. 2012.

(with Cho, H. and Azzam, M.) “Noise Analysis and Negotiation Tool for Terminal RNP Procedure Design “, 2013 Aviation Technology, Integration and Operations (ATIO) Conference, Los Angeles, August 2013.

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(with McConnachie, D and Wollersheim C.) “The Impact of Fuel Price on Airline Fuel Efficiency and Operations“, 2013 Aviation Technology, Integration and Operations (ATIO) Conference, Los Angeles, August 2013.

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(with Sridhar, B., Hok, K. N., Chen,N., Gao, H., Azzam) “Energy Efficient Trajectory Design For Minimizing Climate Impact of Aircraft on Various Timescales“, 2013 Aviation Technology, Integration and Operations (ATIO) Conference, Los Angeles, August 2013.

**Additional Publications** (cont.)

“Analysis of Impact of Aircraft Age on Safety for Air Transport Jet Airplanes”, ICAO Air Navigation Commission, Montreal, January 2014.

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(with Silva, S. and Jensen, L.) “Pilot Perception and Use of ADS-B In Traffic and Weather Services (TIS-B and FIS-B)”, 15<sup>th</sup> AIAA Aviation Technology, Integration and Operations Conference, Dallas, June 2015, <http://arc.aiaa.org/doi/abs/10.2514/6.2015-2849>.

(with Reynolds, T. Rodrigues, Y., McPartland, M., Sandberg, M., and Dumont, J.M.) “Analyzing Delayed Deceleration Approaches”, 15<sup>th</sup> AIAA Aviation Technology, Integration and Operations Conference, Dallas, June 2015.

(with National Research Council), A Review of the Next Generation Air Transportation System – Implications and Importance of System Architecture, Computer Science and Telecommunications Board, National Academy Press, Washington, D.C., 2015.

(with Tao, T.) “Design and Performance of an Adaptable Aircraft Manufacturing Concept” AIAA Aerospace Sciences Meeting, January 2016, AIAA-2016-1526.

(with Tao, T.) “Development of an In-Flight-Deployable Micro-UAV” AIAA Aerospace Sciences Meeting, January 2016, AIAA-2016-1742.

(with Murca, M.C.R, Balakrishnan, H., DeLaura, R., Jordan, R., and Reynolds, T.) “Trajectory Clustering and Classification for Characterization of Air Traffic Flows” 16<sup>th</sup> AIAA Aviation Technology, Integration, and Operations Conference, June 2016, AIAA 2016-3670.

(with Sanberg, M., Thomas J., and Reynolds, T.) “Delayed Deceleration Approach Noise Assessment” 16<sup>th</sup> AIAA Aviation Technology, Integration, and Operations Conference, June 2016.

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R. Delaura, R. Jordan, T. Reynolds, J. Avery, H. Balakrishnan, M. Conde Rocha Murca, K. Gopalakrishnan, R. J. Hansman "Multi-Scale Data Mining for Air Transportation System Diagnostics" AIAA Aviation Technology, Integration, and Operations Conference. (2016)

**PROOF OF SERVICE**

I am employed in the City and County of San Francisco, State of California in the office of a member of the bar of this court at whose direction the following service was made. I am over the age of eighteen years and not a party to the within action. My business address is Kecker, Van Nest & Peters LLP, 633 Battery Street, San Francisco, CA 94111-1809.

On November 16, 2018, I served the following document(s):

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Executed on November 16, 2018, at San Francisco, California.

I declare under penalty of perjury under the laws of the State of California that the above is true and correct.



LEAH PRANSKY